

WHAT IS CLAIMED IS:

1. ~~An image processor which processes multi-level image data on density levels of pixels, comprising:~~

an edge judgement circuit which discriminates an edge direction of a target pixel from differences in density level between the target pixel and adjacent pixels thereof based upon the multi-level image data; and

a density level determining circuit which determines density levels in a plurality of sub-pixels in the target pixel, where the target pixel is divided into the sub-pixels, in accordance with the density level of the target pixel and the edge direction of the target pixel discriminated by the edge judgment circuit.

2. The image processor according to claim 1, wherein the density level determining circuit comprises:

a density controller circuit which sets density-level setting parameters for each of the sub-pixels in the target pixel in accordance with the edge direction of the target pixel discriminated by said edge judgment circuit;

and

a density-level setter circuit which sets the density level of each of the plurality of sub-pixels in the target pixel based upon the density level of the target pixel by using the parameters set by said density controller circuit.

3. The image processor according to claim 1, wherein said edge judgment circuit discriminates a first edge which represents that an edge of a character image exists in a first direction relative to the target pixel, a second edge which represents that an edge of a character image exists in a second direction opposite to the first direction relative to the target pixel, and a narrow edge which represents that a character image exists at a center of the target pixel.

10 4. The image processor according to claim 1, wherein said edge judgment circuit cancels the discriminated edge direction when the density level of a pixel adjacent to the target pixel in the edge direction is larger than a threshold value.

15 5. The image processor according to claim 1, further comprising:

a line width judgment circuit which determines a width of a line including the target pixel;

20 a smoothing circuit which performs smoothing on the image data of the target pixel and the adjacent pixels thereof in accordance to the line width determined by said line width judgment circuit and outputs the image data of the target pixel which have been smoothed;

25 wherein the density level determining circuit determines the density levels in the plurality of sub-

pixels in accordance with the density level of the target pixel subjected to smoothing by said smoothing circuit and the edge direction of the target pixel discriminated by the edge judgment circuit.

- 5 6. The image processor according to claim 5, wherein the density level determining circuit comprises:

a density controller circuit which sets density-level setting parameters for each of the sub-pixels in the target pixel in accordance with the edge direction of the target pixel discriminated by said edge judgment circuit;
10 and

a density-level setter circuit which sets the density level of each of the plurality of sub-pixels in the target pixel based upon the density level of the target pixel by using the parameters set by said density
15 controller circuit.

7. The image processor according to claim 6, wherein said line-width judgment circuit determines the line width of the line including the target pixel based upon the edge direction of the target pixel and those the adjacent pixels
20 of the target pixel discriminated by the edge judgment circuit.

8. The image processor according to claim 1, further comprising an edge judgment correction circuit connected to
25 said edge judgment circuit and corrects the edge direction

when the edge direction discriminated by said edge judgment circuit is not appropriate.

9. The image processor according to claim 8, wherein said density level determining circuit comprises:

5 a density controller circuit which sets parameters for each of the sub-pixels based on the edge direction discriminated by said edge judgment circuit or by said edge judgement correction circuit; and

10 a density-level setter circuit which sets a density level for each of a plurality of sub-regions in the target pixel based upon the density level of the target pixel by using the parameters set by said density controller circuit.

10. The image processor according to claim 1 further comprising a smoothing circuit which performs smoothing on image data of the pixel, on which said edge judgment circuit discriminates an edge, by using an asymmetric filter having the target pixel at a center thereof, wherein said density level determining circuit determines density level of each of the sub-pixels in the target pixel based on the density level of the image data of the target pixel smoothed by said smoothing circuit and on the edge direction of the target pixel discriminated by said edge judgment circuit.

25 11. The image processor according to claim 10,

wherein said density level determining circuit comprises:

a density controller circuit which sets parameters for each of the sub-pixels based on the edge direction discriminated by said edge judgment circuit or by
5 said edge judgement correction circuit; and

a density-level setter circuit which sets a density level for each of a plurality of sub-regions in the target pixel based upon the density level of the target pixel smoothed by said smoothing circuit by using the
10 parameters set by said density controller circuit.

12. The image processor according to claim 10, wherein said filter is asymmetrical with respect to a direction perpendicular to which a pixel is divided into sub-pixels. ✓

15 13. The image processor according to claim 10, wherein said smoothing circuit comprises a plurality of filters and selects one of them for smoothing.

14. The image processor according to claim 10, wherein said smoothing circuit comprises a plurality of
20 filters and selects one of the filters which provides a minimum density level of the target pixel after the smoothing carried by the filters.

15. ~~A method for processing processes multi-level image data on density levels of pixels, where a pixel is divided into a plurality of sub-pixels, comprising the~~

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steps of:

discriminating an edge direction of a target pixel from differences in density level between the target pixel and adjacent pixels thereof based upon the multi-level image data; and

determining density levels in a plurality of sub-pixels in the target pixel in accordance with the density level of the target pixel and the discriminated edge direction of the target pixel.

10 SUB 1517 16. The method according to claim 15, further comprising the steps of:

determining a width of a line including the target pixel; and

15 performs smoothing on the image data of the target pixel and the adjacent pixels thereof in accordance to the determined line width and outputs the image data of the target pixel which have been smoothed;

20 wherein in said step of determining density levels of determines the density levels in the plurality of sub-pixels in accordance with the density level of the target pixel subjected to smoothing and the discriminated edge direction of the target pixel.

17. The method according to claim 15, further comprising the step of correcting the discriminated edge direction when the discriminated edge direction is not

appropriate.

18. ~~The method according to claim 15 further~~
comprising the step of performing smoothing on image data
of the pixel, on which an edge is direction, by using an
5 asymmetric filter having the target pixel at a center
thereof, wherein in said determining step density level of
each of the sub-pixels in the target pixel is determined
based on the density level of the smoothed image data of
the target pixel and on the discriminated edge direction of
10 the target pixel.

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